Comparative table of rainfall for each geographical division.

Divisions.	Relative area.	Number of available stations.	Rainfall.	
			Average for May.	Current for May, 1901.
Northeastern division	25	21	6.20	7.70
Northern and subcentral division	22	54	3.19	7.28
Western-central division	26	26	8.25	10.19
Southern division	27	33	4.38	5.25
General means	....	....	5.51	7.59

In taking the average rainfall Mr. Hall uses only those stations for which he has several years of observation, so that the column of averages represents fairly well the normal rainfall for each division, while the column for the current month represents the average rainfall at those same stations. The relative areas of the divisions are very nearly the same and are given in the preceding table as expressed in percentages of the total area of Jamaica. The number of rainfall stations utilized in each area varies slightly from month to month, according as returns have come in promptly or not, but will not differ greatly from the numbers in the second column of the table.

CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

TABLE 1.—*Hourly observations at the Observatory, San Jose de Costa Rica, during July,* 1901.

Hours.	Pressure.		Temperature.		Relative humidity.		Rainfall.		
	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	Duration, 1901.
	660+ Mm.	660+ Mm.	° C.	° C.	%	%	Mm.	Mm.	Hrs.
1 a. m	3.46	3.70	17.08	17.65	95	91	1.0	1.1	1.49
2 a. m	3.11	3.32	16.75	17.51	95	90	0.1	1.2	0.17
3 a. m	2.95	3.08	16.50	17.11	94	91	0.0	2.5	0.00
4 a. m	2.76	2.98	16.40	17.15	93	91	0.0	1.3	0.00
5 a. m	2.88	3.10	16.25	17.04	93	91	0.0	0.4	0.00
6 a. m	3.00	3.37	16.24	17.00	93	91	0.2	0.5	1.00
7 a. m	3.37	3.76	17.79	18.23	89	87	0.0	0.6	0.00
8 a. m	3.63	3.97	19.77	20.07	80	80	0.0	0.7	0.00
9 a. m	3.86	4.15	21.84	21.64	72	75	0.0	1.2	0.00
10 a. m	3.93	4.13	23.65	22.95	68	70	0.0	0.8	0.00
11 a. m	3.76	4.04	24.08	23.71	69	69	0.0	1.4	0.00
12 m	3.58	3.75	24.40	24.29	70	69	0.0	4.9	0.00
1 p. m	3.14	3.35	23.36	24.11	74	69	8.4	14.8	1.00
2 p. m	2.90	2.94	22.35	23.50	79	73	22.7	19.0	6.68
3 p. m	2.58	2.68	21.45	22.50	83	76	19.3	23.7	7.91
4 p. m	2.52	2.63	20.66	21.45	86	80	53.2	36.9	10.15
5 p. m	2.72	2.83	19.75	20.53	90	83	68.7	34.9	10.88
6 p. m	3.01	3.12	19.05	19.70	92	86	74.7	37.9	11.12
7 p. m	3.37	3.55	18.64	19.04	94	89	48.5	20.7	11.83
8 p. m	3.68	3.97	18.35	18.69	95	89	44.0	13.8	11.67
9 p. m	3.93	4.20	18.09	18.44	95	90	17.3	7.8	7.92
10 p. m	4.10	4.36	17.93	18.16	95	90	15.4	5.6	5.67
11 p. m	4.08	4.35	17.66	17.96	95	90	4.0	2.9	3.08
Midnight	3.86	3.93	17.48	17.81	95	91	4.4	1.8	2.51
Mean	663.34	663.56	19.89	19.85	87	84	......	......	......
Minimum	661.10	659.83	14.4	13.2	51	32	......	......	......
Maximum	665.50	666.42	28.0	29.2	100	100	74.7	37.9	......
Total	......	......	......	......	......	......	398.0	241.0	93.08

REMARKS.—The barometer is 1,169 meters above sea level. Readings are corrected for gravity, temperature, and instrumental error. The dry and wet bulb thermometers are 1.5 meters above ground and corrected for instrumental errors. The hourly readings for pressure, wet and dry bulb thermometers, are obtained by means of Richard registering instruments, checked by direct observations every three hours from 7 a. m. to 10 p. m. The hourly rainfall is as given by Hottinger's self-register, checked once a day. The standard rain gage is 1.5 meters above ground. In the Costa Rican system the San Jose local time is used, which is $0^h\ 36^m\ 13^s.3^s$ slower than seventy-fifth meridian time.

TABLE 2.

Time.	Sunshine.		Cloudiness observed, 1901.	Temperature of the soil at depth of—				
	Observed, 1901.	Normal, 1889-1900.		0.15 *m.*	0.30 *m.*	0.60 *m.*	1.20 *m.*	3.00 *m.*
	Hours.	*Hours.*	%	° C.	° C.	° C.	° C.	° C.
7 a.m	11.72	8.18	70	21.13	21.52	22.20	21.99	21.64
8 a.m	18.89	15.97	......	......	......	......	......	......
9 a.m	24.69	16.42	......	......	......	......	......	......
10 a.m	22.16	15.42	70	21.45	21.58	22.23	22.01	......
11 a.m	16.97	14.94	......	......	......	......	......	......
12 m	13.29	10.32	......	......	......	......	......	......
1 p.m	5.30	9.65	89	21.91	21.70	22.24	22.00	......
2 p.m	4.83	8.84	......	......	......	......	......	......
3 p.m	2.67	7.58	......	......	......	......	......	......
4 p.m	3.42	5.17	96	21.92	21.77	22.19	21.97	......
5 p.m	0.48	3.19	......	......	......	......	......	......
6 p.m	0.00	1.02	......	......	......	......	......	......
7 p.m	......	......	97	21.81	21.71	22.18	21.96	......
8 p.m	......	......	......	......	......	......	......	......
9 p.m	......	......	......	......	......	......	......	......
10 p.m	......	......	77	21.64	21.68	22.18	21.96	......
11 p.m	......	......	......	......	......	......	......	......
Midnight	......	......	......	......	......	......	......	......
Mean	......	......	82	21.66	21.66	22.20	21.98	21.64
Total	124.42	118.52	......	......	......	......	......	......

Notes on the weather.—This month has been characterized on the Pacific slope by two periods of daily and generally heavy rainfall, separated by three days, 13th, 14th, 15th, of fair weather (veranillo); in San José the heaviest showers fell on the 2d and 29th, with 46 and 54 millimeters in 5 and 2 hours, respectively; the temperature was about normal for the season, the mornings being generally clear and bright (only two days without sun). On the Atlantic coast belt the drought continued, while heavy rainfall was reported from the interior.

Earthquakes.—July 11, $9^h\ 31^m$ p. m., slight shock, N-S, intensity II, duration 3 seconds; July 13, $8^h\ 28^m$ a. m., light shock, NNW-SSE, intensity II, duration 2 seconds; July 23, $9^h\ 43^m\ 30^s$ p. m., heavy shock, W-E, intensity III, duration 20 seconds; July 25, $2^h\ 40^m$ p. m., heavy shock, WNW-ESE, intensity III, duration 17 seconds; July 25, $7^h\ 1^m$ p. m., light tremors, N-S, intensity II, duration 5 seconds.

TABLE 3.—*Rainfall at stations in Costa Rica, July,* 1901.

Stations.	Amount.	No. rainy days.	Stations.	Amount.	No. rainy days.
	Mm.			*Mm.*	
1. Sipurio (Talamanca)	287	20	14. Juan Vinas	111	31
2. Boca Banano	141	14	15. Santiago	290	22
3. Limon	129	8	16 Paraiso	88	23
4. Swamp Mouth	128	6	17. Las Concavas	......	......
5. Zent	......	......	18. Cartago	......	......
6. Gute Hoffnung	275	14	19. Tres Rios	473	27
7. Siquirres	303	16	20. S. Francisco G	407	25
8. Guapiles	138	17	21. San Jose	398	24
9. Sarapiqui	......	......	22. La Verbena	415	27
10. San Carlos	332	26	23. Alajuela	466	25
11. Las Lomas	380	16	24. San Isidro Alajuela	549	27
12. Peralta	273	23	25. Nuestro Amo	369	29
13. Turrialba	291	22			

MEXICAN CLIMATOLOGICAL DATA.

Through the kind cooperation of Señor Manuel E. Pastrana, Director of the Central Meteorologic-Magnetic Observatory, the monthly summaries of Mexican data are now communicated in manuscript, in advance of their publication in the Boletin Mensual. An abstract, translated into English measures, is here given, in continuation of the similar tables published in the MONTHLY WEATHER REVIEW since 1896. The barometric means are now reduced to standard gravity.

Mexican data for July, 1901.

Stations.	Altitude.	Mean barometer.*	Temperature. Max.	Temperature. Min.	Temperature. Mean.	Relative humidity.	Precipitation.	Prevailing direction. Wind.	Prevailing direction. Cloud.
	Feet.	*Inch.*	° *F.*	° *F.*	° *F.*	%	*Inch.*		
Culiacan Ros. (Sin.) ..	112	29.60	104.0	77.8	87.4	70	5.22	ssw.,sw.	ne.
Durango (Seminario)	6,243	23.94	102.7	51.8	71.8	54	1.78	ese.	e,
Leon (Guanajuato)...	5,906	24.21	88.3	56.3	70.2	67	3.18	se,	e.
Linares (Nuevo Leon).	1,188	28.60	96.8	68.0	81.9	72	1.38	s.	s.
Mazatlan	25	29.79	89.2	75.0	82.8	78	13.46	nw.	e.
Mexico (Obs. Cent.) ..	7,472	22.99	76.1	52.7	62.2	72	6.90	n.	....
Morelia (Seminario) ..	6,401	23.89	76.8	51.6	62.4	82	12.37	se.	e.
Puebla (Col. Cat.) ...	7,125	23.32	78.3	53.6	66.0	70	6.52	ene.	ssw.
Saltillo (Col. S. Juan).	5,399	24.73	86.0	59.0	70.7	75	5.47	n.	ne.
S. Isidro (Hac. de Gto)	......	......	78.4	68.0	......	......	4.83	ne,	....
Toluca	8,812	21.91	72.9	36.5	58.5	74	5.94	s.	....

* Reduced to standard temperature and gravity.

SUPPLEMENTARY REMARKS ON THE THEORY OF THE FORMATION OF RAIN ON MOUNTAIN SLOPES.[1]

By Prof. Dr. F. POCKELS.

(1.) Assuming the average vertical distribution of temperature and moisture for each of the four seasons of the year as it is deduced by von Bezold from the scientific balloon ascensions published by Berson and Assmann in their "Ergebnissen," "The results of scientific balloon voyages," there result the following minimum elevations required in order that condensation may begin in a mass of air that was originally at the absolute altitude H above sea level.

H.	Spring-time.	Summer.	Autumn.	Winter.
Meters.	*Meters.*	*Meters.*	*Meters.*	*Meters.*
0	725	850	405	400
500	485	710	615	760
1,000	855	570	600	1,070
1,500	890	680	835	1,140
2,000	9:0	780	1,180	1,100
3,000	830	1,060	1,208	1,130
4,000	700	1,125	1,240	1,100

The smallest number in each colums is also the smallest altitude that a mountain ridge must possess in order to cause the formation of clouds under the assumed conditions, but it is only in the case of a very broad mountain ridge that such small altitude will suffice. We see that in the autumn and winter a mountain of about 400 meters in height will suffice to produce a formation of cloud in contact with the summit of the mountain, whereas in spring and summer, the mountain must be higher (namely about 500 or 570 meters respectively), and when the air passes over this mountain the formation of cloud will begin in the layer lying at 500 or 1,000 meters above its summit. These numbers at present serve only as examples; in practice, however, they suggest that as soon as we observe the formation of cloud above a mountain of less altitude than the above given tabular minimum altitude, we may conclude somewhat as to the average moisture at that altitude at that time. We may also remark that on account of the increasing flatness of the lines of flow as the altitude increases, the above given minimum altitudes must be exceeded by so much the more in proportion as the width of the summit ridge is smaller, and the altitude of the layer in which the condensation begins is higher.

(2.) The method developed by me for computing the condensation that occurs on any given mountain slope can not be applied to computing the mean value of the precipitation for any given interval of time, by introducing into the computation the mean values of the temperature and moisture for this interval. We should in this way find too small a precipitation. Thus, for example, the altitude of the mountains might not suffice to cause any condensation at all for the average condition of the air, but could cause it on those occasions when the moisture exceeds its average value, wherefore the average value of the rainfall for the interval of time under consideration would be different from zero. As the variation of the moisture from its average value may cause rainfalls where otherwise there would be none, so also, with the currents of air mechanically forced to ascend mountain ranges, and whose effect is superposed upon that of the general circulation of the air in cyclonic areas; for it can happen that neither one of these two causes may alone suffice to form rain, but that both together do. This explains why elevations of the surface of the earth of from 100 to 200 meters increase the annual mean value of the total precipitation, as for instance, as shown by the charts in Assmann's memoir of 1886, "Einfluss, etc." "On the influence of mountains on the climate of central Germany."

(3.) The examples given in my article show that in so far as condensation in general takes place on the slopes of mountains, its intensity (therefore also, the density of the precipitation when falling vertically) is in general greatest where the slope of the mountain is steepest. If now we consider that in the course of all the various conditions of the atmosphere that may occur in a long interval of time, the first condensation occurs most frequently above the upper portion of the slope, then it follows that the average density of precipitation computed for a long interval of time, must increase, not only with the inclination of the slope, but also with the absolute altitude of the locality under consideration. To this case corresponds the formula for the annual quantity of precipitation expressed in milimeters deduced by Dr. R. Huber in his "Untersuchungen, etc." investigation of the distribution of precipitation in the canton of Basle, namely:

$$N = 793 + 0.414\,h + 381.6 \tan \alpha$$

where h is the altitude in meters, and α indicates the gradient angle. (See A. Riggenbach, Verhandlung der Naturforschenden Gesellschaft. Basel, 1895. Vol. X, p. 425).

(4.) From a comparison of the effects of different broad mountain ranges of the same altitude, it results (see page 474 of my article, or page 157 of the translation in the MONTHLY WEATHER REVIEW) that the smaller, and therefore steeper, mountains always cause a smaller total condensation than the broader and narrower mountain summits. Notwithstanding this, the density of precipitation on the slope of the smaller is generally larger than on the slope of the larger mountains because the smaller total precipitation is distributed over a ground surface that is relatively much smaller yet. In reality, however, this only obtains so long as the quantity of water remaining suspended in the cloud is only a small fraction of the total condensation; in the case of very narrow mountain ridges it will be more apt to happen that a considerable fraction passes on over and beyond the summit and is subsequently again evaporated [and therefore does not appear as rainfall].

(5.) I regret to notice that in the first two figures of my original memoir, as also in the translation, the legend inscribed on the curves representing the distribution of precipitation reads "precipitation in millimeters per second," instead of "per hour," as is correctly stated in the text; the necesary correction should be made.

(6.) A precise test of this theory can not at present be carried out, because we have not sufficient observations of the

[1] The translation of the important memoir by Professor Pockles, of Heidelberg, published on pages 152–159 of the MONTHLY WEATHER REVIEW for April, 1901, was prepared and published quite promptly, without waiting for any subsequent corrections and notes by the author. A modified draft of the original memoir was published in the Meteorologische Zeitschrift for July, 1901, and Professor Pockles now requests that the following additional remarks may be published.